

**Biochemical Genetic Stock Identification
of Chum Salmon in
Southern British Columbia, 1986**

M.C. Vreeling, L. Hop Wo, A.P. Gould,
W. Luedke, S.R. Heizer and T.D. Beacham

Fisheries Branch
Department of Fisheries and Oceans
3225 Stephenson Point Road
Nanaimo, British Columbia V9T 1K3

April 1987

Canadian Data Report of
Fisheries and Aquatic Sciences
No. 634

Canadian Data Report of Fisheries and Aquatic Sciences

Data reports provide a medium for filing and archiving data compilations where little or no analysis is included. Such compilations commonly will have been prepared in support of other journal publications or reports. The subject matter of data reports reflects the broad interests and policies of the Department of Fisheries and Oceans, namely, fisheries and aquatic sciences.

Data reports are not intended for general distribution and the contents must not be referred to in other publications without prior written authorization from the issuing establishment. The correct citation appears above the abstract of each report. Data reports are abstracted in *Aquatic Sciences and Fisheries Abstracts* and indexed in the Department's annual index to scientific and technical publications.

Numbers 1-25 in this series were issued as Fisheries and Marine Service Data Records. Numbers 26-160 were issued as Department of Fisheries and the Environment, Fisheries and Marine Service Data Reports. The current series name was introduced with the publication of report number 161.

Data reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page. Out-of-stock reports will be supplied for a fee by commercial agents.

Rapport statistique canadien des sciences halieutiques et aquatiques

Les rapports statistiques servent à classer et à archiver les compilations de données pour lesquelles il y a peu ou point d'analyse. Ces compilations auront d'ordinaire été préparées à l'appui d'autres publications ou rapports. Les sujets des rapports statistiques reflètent la vaste gamme des intérêts et des politiques du ministère des Pêches et des Océans, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports statistiques ne sont pas destinés à une vaste distribution et leur contenu ne doit pas être mentionné dans une publication sans autorisation écrite préalable de l'établissement auteur. Le titre exact paraît au-dessus du résumé de chaque rapport. Les rapports statistiques sont résumés dans la revue *Résumés des sciences aquatiques et halieutiques*, et ils sont classés dans l'index annuel des publications scientifiques et techniques du Ministère.

Les numéros 1 à 25 de cette série ont été publiés à titre de relevés statistiques, Services des pêches et de la mer. Les numéros 26 à 160 ont été publiés à titre de rapports statistiques du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 161.

Les rapports statistiques sont produits à l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

Canadian Data Report of
Fisheries and Aquatic Sciences No. 634

April 1987

BIOCHEMICAL GENETIC STOCK IDENTIFICATION OF
CHUM SALMON IN SOUTHERN BRITISH COLUMBIA, 1986

by

M.C. Vreeling, L. Hop Wo, A.P. Gould,
W. Luedke, S.R. Heizer and T.D. Beacham¹

Department of Fisheries and Oceans
Fisheries Branch
3225 Stephenson Point Road
Nanaimo, British Columbia V9T 1K3

¹ Department of Fisheries and Oceans
Fisheries Research Branch
Pacific Biological Station
Nanaimo, British Columbia
V9R 5K6

(c) Minister of Supply and Service Canada 1987

Cat. No. FS 97-13/634E

ISSN 0706-6465

Correction citation for this publication:

Vreeling, M.C. L. Hop Wo, A.P. Gould, W. Luedke, S.R. Heizer and T.D. Beacham. 1987. Biochemical Genetic Stock Identification of chum salmon in southern British Columbia, 1986. Can. Data Rep. Fish. Aquat. Sci. No. 634: 19p.

TABLE OF CONTENTS

	Page
ABSTRACT	iv
INTRODUCTION	1
METHOD	2
RESULTS	3
ACKNOWLEDGEMENTS	4
LITERATURE CITED	5
LITERATURE CITED (cont'd).....	6

List of Tables

Table 1	Allelic Frequencies by week for Troll	7
Table 2	Allelic Frequencies by week for Johnstone Strait	7
Table 3	Allelic Frequencies by week for Georgia Strait	7
Table 4	Allelic Frequencies by week for San Juan	8
Table 5	Allelic Frequencies by week for Nitinat	8
Table 6	Chum stock composition from the West Coast Commercial troll fishery (Area 127)	9
Table 7	Chum stock compositions from the Upper Johnstone Strait test fishery (Area 12)	10
Table 8	Chum stock compositions from the Mid Vancouver Island commercial fishery (Area 14)	11
Table 9	Chum stock compositions from the San Juan test fishery (Area 20)	12
Table 10	Chum stock compositions from the Nitinat commercial and test fishery (Area 21)	13

List of Figures

Fig. 1	Regions in which chum salmon were sampled during the 1986 season: (1) Northwest Vancouver Island (2) Johnstone Strait (3) Mid Vancouver Island (4) San Juan (5) Nitinat	15
Fig. 2	Chum test fishing sites for the Johnstone Strait region	17
Fig. 3	Chum test fishing sites for the San Juan region	19

ABSTRACT

Vreeling, M.C., L. Hop Wo, A.P. Gould, W. Luedke, S.R. Heizer and T.D. Beacham. 1987. Biochemical Genetic Stock Identification of Chum Salmon in Southern B.C., 1986. Can. Data Rep. Fish. Aquat. Sci. No. 634: 19p.

Genetic variability among chum salmon stocks were used to estimate stock composition in both commercial and test fisheries in Southern British Columbia.

North and Central Coast and Queen Charlotte Island chum stocks comprised the main component in the northwest coast Vancouver Island troll fishery. The dominant stock in the Johnstone Strait fishery was the chum salmon of Johnstone and Georgia Strait origin. Georgia Strait chum salmon was the dominant run migrating through the Mid Vancouver fishery. Fraser River, Georgia Strait, West Coast Vancouver Island and U.S. stocks were mixed in the San Juan fishery. While West Coast Vancouver Island chum salmon the main component in the Nitinat fishery.

With the ability to identify these stocks, managers are able to structure new fisheries to minimize interception of non-target stocks as well as increase flexibility in fishery management.

Key words: chum salmon, genetic stock identification, fishery management.

RESUME

Vreeling, M.C., L. Hop Wo, A.P. Gould, W. Luedke, S.R. Heizer and T.D. Beacham. 1987. Biochemical Genetic Stock Identification of Chum Salmon in Southern B.C., 1986. Can. Data Rep. Fish. Aquat. Sci. No. 634: 19p.

Les auteurs ont utilisé les différences génétiques entre les stocks de saumon keta pour estimer la composition des prises de pêches commerciaux et d'essai effectuées dans le sud de la Colombie-Britannique. Les stocks de saumon keta des parties nord et centre de la côte ainsi que de l'île de la Reine-Charlotte constituent la majorité des prises de la pêche à la traîne effectuée au large de la côte nord-ouest de l'île Vancouver. Les prises de la pêche du détroit Johnstone étaient surtout composées de saumons ketas provenant de ce détroit et du détroit de Géorgie. Les saumons ketas du détroit de Géorgie constituaient le principal groupe en migration exploité par la pêche de la partie centrale de l'île Vancouver. Les prises de la pêche de San Juan étaient constituées de poissons des stocks du fleuve Fraser, du détroit de Géorgie, de la côte ouest de l'île Vancouver et des Etats-Unis. Les saumons ketas de la côte ouest de l'île Vancouver dominaient les prises de la pêche de Nitinat.

Disposant de moyens d'identifier ces stocks, les gestionnaires peuvent structurer les nouvelles pêches de façon à minimiser l'interception des stocks non visés et à accroître la souplesse de la gestion des pêches.

INTRODUCTION

Chum salmon returning to spawn in rivers tributary to Johnstone and Georgia Straits migrate primarily from the north through Johnstone Strait (Anderson and Beacham 1983), although in some years there can be a component of the run returning from the south through Juan de Fuca Strait (Beacham et al. 1987). The identification of the origins of chum salmon in these fisheries has become an increasing problem for management. In response to this problem a genetic method of stock identification (electrophoretics) has been employed since 1981 (Beacham et al. 1985). Domestically, this method has provided managers with the opportunities to assess the need to structure new fisheries to minimize interception of non-target stocks as well as to increase flexibility in fishery management. Internationally, stock identification results are used in identifying catch by country of origin and hence are used in implementing the terms of the Pacific Salmon Treaty between Canada and the U.S.

The largest mixed stock fishery in British Columbia occurs in Johnstone Strait. Different methods of stock identification have been examined for chum salmon. External tagging was an early method of stock identification which provided an understanding of general stock migration patterns (Pritchard 1929, 1931; Chatwin 1953; Manzer 1954; Anderson and Beacham 1983). It could not, however, provide timely in-season estimates of stock composition.

Variation in scale characters have been used in stock identification of chum salmon (Tanaka et al. 1969; Kovtun 1983; Nikolayeva and Semenets 1983). Meristic and morphometric studies were also conducted with only limited success (Beacham et al. 1983). None of these methods provides the ability to estimate stock composition during the fishery season.

Measuring genetically determined variations in protein structure in chum salmon stocks has shown promise for reliable estimates of stock composition (Wishard 1980; Okazaki 1981; Beacham et al 1985). In British Columbia initial surveys for biochemical genetic variation in chum salmon began in 1981 with the objective of providing managers with the ability to identify Fraser River chum salmon in a mixed stock fishery. Since 1981 additional baseline sampling has provided separation of other major chum stock areas.

Currently genetic stock identification (GSI) has provided managers of chum fisheries with the ability to discriminate between chum stocks from six major regions: (1) Queen Charlotte Islands; (2) North and Central coast; (3) West Coast of Vancouver Island; (4) Fraser River; (5) Johnstone and Georgia Strait area; (6) Washington State (U.S.A.) (Beacham et al. 1987). This report details the methods and results of stock identification for chum salmon in southern British Columbia fisheries using electrophoretic GSI for the 1986 season.

METHOD

(1) Collection

Collection of GSI samples occurred in the following fishing areas: Northwest coast of Vancouver Island (Area 111 & 127); Johnstone Strait (Area 12); Mid Vancouver Island (Area 14); San Juan (Area 20); Nitinat (Area 21); (Fig. 1). Samples were taken in order to determine the stock composition in these mixed fisheries.

In general, 150 chum salmon were sampled per week or, in the case of commercial fisheries, per fishing period. Tissue samples of heart, liver and muscle were collected within 24 hours of catch, frozen, and sent, packed with dry ice for electrophoretic analysis. Processing was done by a consultant using the horizontal starch gel technique described by Utter et al. (1974).

Chum samples from the troll fishery off the northwest coast of Vancouver Island were randomly selected from day trollers returning to Winter Harbour. Variability in the number of chum salmon landed daily limited the consistency in sampling effort. A sample of insignificant size was obtained in Area 111 during July. Sampling commenced in Area 127 on June 2 and ended on August 4.

Samples from the Johnstone Strait fishery (Area 12) were collected by a chartered test fishing seine vessel at predetermined sites (Fig. 2). Each year test fishing vessels are chartered for stock assessment during which time electrophoretic samples are collected. Test fishing in the Hanson Island region commenced early September and a second test vessel commenced three weeks later in the Cracroft Point - Robson Bight region. Traditionally only the Hanson Island - Double Bay region was sampled. The second vessel was added to confirm existing stocks as well as provide an independent estimate of stock abundance. Test fishing continued in both regions till early November.

The sampling in the Mid Vancouver Island (Area 14) commercial fishery commenced on October 5 and continued for 5 weeks until November 3. Commercial fish packing vessels were boarded weekly in Comox Bay and Deep Bay to obtain randomly selected samples.

A D.F.O. test fishing vessel was chartered by D.F.O. to collect samples in the San Juan (Area 20) region. Sampling on a weekly basis began September 23 and was concluded on October 31. Sample sites were predetermined and chosen based on abundance (Fig. 3). Sampling was designed to avoid targeting on local stocks. Samples of approximately 150 fish were collected over a 3-5 day period stratified between the 6 different fishing sites each day.

In the Nitinat region (Area 21) samples were collected from fish plants in Ucluelet rather than on the fishing grounds as fish were more accessible in processing plants. Three samples from the commercial fishery were collected, one each week, beginning in September. Two additional samples were collected from the area test fishing vessel beginning the 4th week of September.

(2) Analysis

After the electrophoretic analysis had been completed by the consultant, stock composition in the test fisheries was estimated by the method of Fournier et al. (1984), using the genotypic frequencies for the baseline stocks as outlined by Beacham et al. (1987). The allocation method was similar to that outlined by Beacham et al. (1987). Standard deviations of the estimates were determined by bootstrap simulations where 50 new mixtures were constructed by sampling the original mixture with replacement. Stock composition was then estimated for each of these new mixtures and standard deviations derived from the 50 estimates.

RESULTS

Regional differentiation of allelic frequencies for chum salmon was observed and are presented in Tables 1 through 5. The most common allele at a locus was designated 100 and other alleles were assigned numbers according to the mobility of their homomeric protein products.

The results of biochemical genetic variants indicated that variation among regions is substantially greater than among stocks within regions. This enables managers to provide in-season and post-season estimates of stock composition for use in fisheries management.

North Coast, Central Coast and Queen Charlotte Island chum were the main component in the troll fishery off the northwest coast of Vancouver Island. Composition of Fraser River, Georgia Strait and U.S. chum were insignificant in the troll fishery (Table 6).

The results obtained from both test vessels (Hanson Island, Cracroft Point - Robson Bight) located in the Johnstone Strait were consistent with each other. An estimated peak of Fraser River chum salmon abundance in Johnstone Strait was during the week of September 27. Johnstone and Georgia Strait chum peaked in the fishery two weeks later during October 11 to October 18. An insignificant component of U.S. fish were recorded (Table 7).

Johnstone and Georgia Strait chum salmon were the main component in the Mid Vancouver Island fishery (Table 8). The U.S. return peaked in the Mid Vancouver Island fishery during the week of October 11 while the Fraser River run peaked during the week of October 25.

Sampling in the San Juan fishery indicated substantial mixing of Fraser River, Georgia Strait, West Coast Vancouver Island and U.S. chum salmon (Table 9). Georgia Strait chums were, however, the major stock component.

West Coast Vancouver Island chum salmon were the dominant stock in the Nitinat fishery. Fraser River, Georgia Strait, and U.S. chums comprised an insignificant component in the Nitinat area (Table 10).

The stock composition expressed as percentages by major areas of concern (Fraser River; Johnstone and Georgia Strait; United States; West Coast Vancouver Island; North and Central Coast and Queen Charlotte Islands) are depicted in Tables 6 through 10.

ACKNOWLEDGEMENTS

The extensive field sampling necessary for this program would not have been accomplished without the help of many people. Among those involved were Al Dunlop, Jim Lettic, Jim Mitchell, Matt Palmer, Dave Ritchie, Bob Sewid, James Sewid, Oswald Sewid, Arnie Sorenson, "Moon" Stauffer, Alf Stefanson and Ivan Winthrop. We would also wish to thank Kingfisher Ent., in Parksville, Ocean Fish in Vancouver, Seafood Products in Port Hardy, Sliammon Hatcheries in Powell River and Trans Pacific Fish in Ucluelet for their cooperation in obtaining biological samples. The electrophoretic analysis of stocks was conducted by Helix Biotech Ltd. of Richmond, British Columbia, under contract to the Department of Fisheries and Oceans.

LITERATURE CITED

- Anderson, A.D. and T.D. Beacham, 1983. The migration and exploitation of chum salmon stocks of the Johnstone Strait - Fraser River study area, 1962 - 1970. Can. Tech. Rep. Fish. Aquat. Sci. 1166: 125p.
- Beacham T.D., A.P. Gould and A.P. Stefanson, 1983. Size, age, meristics and morphometrics of chum salmon returning to southern British Columbia during 1981 - 82. Can. Tech. Rep. Fish. Aquat. Sci. 1207: 37p.
- Beacham, T.D., A.P. Gould, R.E. Withler, C.B. Murray, and L.W. Barner. 1987. A Biochemical genetic survey and stock identification of chum salmon (Oncorhynchus keta) in British Columbia. Can. J. Fish. Aquat. Sci. (in press).
- Beacham, T.D. R.E. Withler, and A.P. Gould. 1985. Biochemical genetic stock identification of chum salmon (Oncorhynchus keta) in southern British Columbia. Can. J. Fish. Aquat. Sci. 42: 437-448p.
- Chatwin, B.M. 1953. Tagging of chum salmon in Johnstone Strait 1949 and 1950. Bull. Fish. Res. Board Can. 96: 33p.
- Fournier, D.A., T.D. Beacham, B.E. Riddell, and C.A. Busack. 1984. Estimating stock composition in mixed stock fisheries using morphometric, meristic, and electrophoretic characteristics. Can.J. Fish. Aquat. Sci. 41: 400-408p.
- Kovtun, A.A. 1983. Scale structure of autumn chum salmon stocks of the west coast of Vancouver Island, 1951-1982, Statistical Areas 22-27. Can. Tech. Rep. Fish. Aquat. Sci. 1366: 150p.
- Manzer, J.I. 1954. Pink and chum salmon studies during 1953. Johnstone Strait tagging. West. Fish. 47: 21p.
- Nikolayeva, Ye. T., and N.I. Semenets. 1983. A contribution to stock differentiation of chum salmon, Oncorhynchus keta (Salmonidae), by scale structure in the first year of growth. J. Ichthyol. 23: 18-28p.
- Okazaki, T. 1981. Geographic distribution of allelic variations of enzymes in chum salmon (Onchorhynchus keta) populations of North America. Bull. Jpn. Soc. Sci. Fish. 47: 507-514p.
- Pritchard, A.L. 1929. The tagging of chum salmon , 1928. Prog. Rep. Pac. Bio. Stn. 3: 9p.
1931. The tagging of pink and chum salmon in British Columbia in 1929. Prog. Rep. Pac. Biol. Stn 9: 13-14p.

LITERATURE CITED (cont'd)

- Tanaka, S., M.P. Shepard and H.T. Bilton. 1969. Origin of chum salmon (Oncorhynchus keta) in offshore waters of the North Pacific in 1956-1958 as determined from scale studies. Int. North Pac. Fish. Comm. Bull. 26: 57-155p.
- Utter, F.M., H.O. Hodgins, and F.W. Allendorf. 1974. Biochemical genetic studies of fishes: potentialities and limitations, pp. 213-237. In: D. Malins (Ed.) Biochemical and biophysical perspectives in marine biology. Vo. 1. Academic Press, San Francisco, CA.
- Wishard, L. 1980. Stock identification of Pacific Salmon in western Washington using biochemical genetics. Final report of Wash. Dep. Fish. Serv. Contracts No. 1176-1276, Olympia, WA.

TABLE 1
ALLELIC FREQUENCIES FOR WEST COAST THOLL - 1986

WEK	SUB AREA	LOCUS													
		IDH-1		P-6-G		ME-1		AGS-2		IDH-3		P4H		UGS	
		(N)	100 60	(N)	100 90	(N)	100 125	(N)	100 95	(N)	25 40 85	(N)	100 90	(N)	100 75
11-CT-46	113	0.863 0.137	114 1.000 0.000	112 0.871 0.129	110 0.890 0.150	114 0.184 0.360 0.075 0.362	114 0.912 0.088	109 0.872 0.128							
18-CT-46	148	0.919 0.081	148 0.990 0.010	148 0.875 0.125	147 0.857 0.143	149 0.151 0.396 0.091 0.362	149 0.886 0.114	146 0.805 0.195							
25-CT-46	168	0.872 0.128	180 0.992 0.008	174 0.856 0.144	178 0.860 0.140	178 0.149 0.396 0.073 0.382	179 0.888 0.112	163 0.898 0.104							

TABLE 2
ALLELIC FREQUENCIES FOR JONESTOWN STRAIT - 1986

WEK	LOCUS																							
	IDH-1			P-6-G			ME-1			ADP-2			1034-5			PMT			LGD					
	(N)	100	60	(N)	100	90	(N)	100	125	(N)	100	95	(N)	25	40	85	100	100	(N)	100	90	(N)	100	75
08-Sep-86	Harrison 18.	138	0.924	0.076	141	0.996	0.004	140	0.350	0.150	140	0.929	0.071	140	0.061	0.221	0.132	0.566	139	0.903	0.093	137	0.836	0.164
13-Sep-86	Harrison 18.	150	0.927	0.073	150	0.990	0.010	149	0.339	0.161	152	0.957	0.043	150	0.055	0.237	0.075	0.637	151	0.881	0.119	148	0.875	0.125
20-Sep-86	Harrison 18.	149	0.940	0.060	150	1.000	0.000	150	0.320	0.180	150	0.950	0.050	150	0.077	0.233	0.053	0.637	148	0.889	0.111	149	0.926	0.074
27-Sep-86	Harrison 18.	149	0.919	0.081	150	1.000	0.000	149	0.856	0.144	149	0.936	0.064	150	0.090	0.300	0.033	0.577	146	0.921	0.079	147	0.959	0.081
04-Oct-86	Harrison 18.	148	0.936	0.064	148	0.997	0.003	148	0.787	0.213	147	0.912	0.088	148	0.084	0.284	0.037	0.595	146	0.914	0.086	145	0.817	0.183
11-Oct-86	Harrison 18.	144	0.944	0.056	148	0.997	0.003	149	0.782	0.218	147	0.936	0.064	149	0.057	0.248	0.054	0.641	150	0.880	0.120	135	0.816	0.184
18-Oct-86	Harrison 18.	147	0.918	0.082	150	0.997	0.003	147	0.820	0.180	142	0.961	0.039	149	0.081	0.295	0.034	0.591	147	0.908	0.092	148	0.851	0.149
25-Oct-86	Harrison 18.	150	0.923	0.077	149	0.990	0.010	149	0.802	0.198	149	0.936	0.064	149	0.084	0.252	0.040	0.624	150	0.907	0.093	149	0.799	0.201
01-Nov-86	Harrison 18.	149	0.923	0.077	149	1.000	0.000	149	0.809	0.191	147	0.959	0.041	147	0.056	0.269	0.048	0.626	148	0.885	0.115	146	0.755	0.247
08-Nov-86	Harrison 18.	149	0.931	0.069	149	0.997	0.003	149	0.809	0.191	147	0.936	0.064	149	0.087	0.295	0.048	0.614	149	0.886	0.114	146	0.791	0.248
27-Sep-86	Robinson 87.	149	0.936	0.064	149	0.997	0.003	148	0.745	0.245	148	0.920	0.080	150	0.077	0.325	0.043	0.557	144	0.910	0.090	145	0.862	0.138
04-Oct-86	Robinson 87.	145	0.910	0.090	144	0.990	0.010	144	0.799	0.201	148	0.936	0.064	147	0.082	0.245	0.085	0.609	146	0.928	0.072	149	0.869	0.131
11-Oct-86	Robinson 87.	147	0.949	0.051	150	0.997	0.003	148	0.811	0.189	150	0.950	0.050	149	0.077	0.295	0.037	0.591	149	0.915	0.087	150	0.845	0.155
18-Oct-86	Robinson 87.	150	0.927	0.073	150	1.000	0.000	150	0.787	0.213	149	0.970	0.030	148	0.043	0.277	0.600	0.620	150	0.897	0.103	147	0.881	0.119
25-Oct-86	Robinson 87.	150	0.927	0.073	150	0.997	0.003	150	0.850	0.150	150	0.953	0.047	148	0.054	0.348	0.071	0.527	150	0.877	0.120	144	0.840	0.160
01-Nov-86	Robinson 87.	148	0.919	0.081	149	0.997	0.003	148	0.791	0.209	147	0.946	0.054	149	0.057	0.305	0.087	0.581	149	0.909	0.091	148	0.824	0.176
08-Nov-86	Robinson 87.	148	0.922	0.078	148	0.993	0.007	148	0.791	0.209	146	0.959	0.041	148	0.084	0.324	0.084	0.547	147	0.901	0.099	145	0.769	0.231

TABLE 3
ALLELIC FREQUENCIES FOR GEORGIA STRAIT - 1986

WEK	LOCUS																							
	IDH-1			P-6-G			ME-1			AQP-2			IDH-3			P4H			LOC					
	(N)	100	60	(N)	100	90	(N)	100	125	(N)	100	95	(N)	25	40	85	100	100	90	100	75			
11-CT-46	14-5, 7	108	0.917	0.083	108	1.000	0.000	105	0.757	0.243	105	0.953	0.047	106	0.057	0.316	0.052	0.575	109	0.881	0.119	107	0.780	0.220
18-CT-46	14-5, 7	148	0.922	0.078	148	0.997	0.003	146	0.808	0.192	139	0.953	0.047	145	0.099	0.299	0.058	0.645	149	0.889	0.111	146	0.771	0.229
25-CT-46	14-5, 7	149	0.949	0.051	144	0.993	0.007	144	0.806	0.194	142	0.940	0.060	141	0.071	0.294	0.055	0.599	145	0.909	0.091	144	0.771	0.229
01-Nov-86	14-5, 7	150	0.936	0.064	149	0.993	0.007	149	0.765	0.235	144	0.958	0.042	145	0.062	0.238	0.072	0.628	148	0.899	0.101	144	0.823	0.177
08-Nov-86	14-5, 7	135	0.952	0.048	137	0.989	0.011	135	0.737	0.263	136	0.967	0.033	136	0.081	0.261	0.056	0.643	136	0.906	0.094	137	0.799	0.201
14-5, 7	14-5, 7	149	0.940	0.060	148	0.997	0.003	147	0.823	0.177	142	0.951	0.049	147	0.051	0.295	0.085	0.599	148	0.891	0.109	140	0.807	0.193
08-Nov-86	14-5, 7	149	0.935	0.065	148	0.993	0.007	149	0.792	0.208	140	0.946	0.054	142	0.042	0.243	0.082	0.615	145	0.910	0.090	146	0.791	0.209

TABLE 4

ALLELIC FREQUENCIES FOR THE WEST COAST - 1986

M.E.R.	LUR-1					P-O-G					ME-1					AG-2					LUR-3					PM					LUG				
	100		60		(N)	100		90		(N)	100		125		(N)	100		95		(N)	25		40		85		100		90		(N)	100		75	
	(N)		(N)			(N)		(N)			(N)		(N)			(N)		(N)			(N)		(N)		(N)		(N)		(N)			(N)		(N)	
18-DET-46	150	0.957	0.045		150	1.000	0.000		150	0.767	0.233		146	0.976	0.024		146	0.169	0.291		146	0.169	0.291		147	0.912	0.088		147	0.912	0.088		148	0.760	0.240
25-DET-46	150	0.959	0.041		150	0.996	0.004		150	0.771	0.229		146	0.977	0.023		140	0.121	0.500		140	0.121	0.500		150	0.885	0.115		150	0.885	0.115		150	0.777	0.223
18-DET-46	151	0.944	0.056		151	0.997	0.003		150	0.857	0.143		146	0.987	0.013		151	0.126	0.508		151	0.126	0.508		150	0.945	0.055		150	0.945	0.055		151	0.847	0.153
18-DET-46	150	0.947	0.053		150	0.997	0.003		150	0.853	0.147		146	0.983	0.017		145	0.179	0.297		145	0.179	0.297		147	0.912	0.088		147	0.912	0.088		148	0.816	0.184
18-DET-46	144	0.944	0.056		149	1.000	0.000		145	0.765	0.235		146	0.998	0.002		144	0.165	0.295		144	0.165	0.295		147	0.901	0.099		147	0.901	0.099		148	0.769	0.231

TABLE 5

ALLELIC FREQUENCIES FOR SAN JUAN - 1986

M.E.R.	LUR-1					P-O-G					ME-1					AG-2					LUR-3					PM					LUG							
	100		60		(N)	100		90		(N)	100		125		(N)	100		95		(N)	25		40		85		100		(N)	100		90		(N)	100		75	
	(N)		(N)			(N)		(N)			(N)		(N)			(N)		(N)			(N)		(N)		(N)		(N)			(N)		(N)			(N)		(N)	
11-DET-46	147	0.929	0.071		147	0.997	0.003		147	0.795	0.205		154	0.946	0.054		145	0.089	0.524	0.072	0.534	141	0.929	0.071		141	0.929	0.071		146	0.945	0.055						
18-DET-46	150	0.880	0.120		150	0.997	0.003		150	0.800	0.200		149	0.945	0.055		148	0.118	0.277	0.088	0.557	150	0.877	0.123		150	0.877	0.123		144	0.908	0.092						
25-DET-46	150	0.907	0.093		150	0.990	0.010		150	0.767	0.233		149	0.940	0.060		146	0.096	0.240	0.072	0.592	150	0.915	0.085		150	0.915	0.085		150	0.815	0.185						
25-DET-46	150	0.865	0.135		150	0.990	0.010		149	0.775	0.225		148	0.882	0.118		150	0.087	0.247	0.085	0.585	150	0.870	0.130		150	0.870	0.130		150	0.747	0.253						
01-DET-46	100	0.990	0.010		100	1.000	0.000		100	0.770	0.230		100	0.920	0.080		100	0.080	0.215	0.105	0.600	97	0.902	0.098		97	0.902	0.098		100	0.775	0.225						
01-DET-46	199	0.887	0.113		200	0.998	0.002		196	0.778	0.222		199	0.912	0.088		198	0.106	0.247	0.091	0.556	200	0.882	0.117		200	0.882	0.117		199	0.711	0.289						

TABLE 6. Electrophoretic results from the west coast Vancouver Island troll fishery (Area 1-27), 1986.

1986 STOCK COMPOSITION - AREA 1-27

Area	Sample Date	Samp. Size	% FR	% JS/GS	% US	% WCVI	% NC,CC,QCI
127	JUN 29,JUL 7-13	114	12.1 (9.4)	0.6 (1.5)	3.2 (4.9)	0.1 (0.1)	84.0 (10.6)
127	JULY 14-18	149	14.9 (12.4)	0.8 (2.2)	2.6 (4.1)	8.4 (7.1)	73.4 (10.6)
127	JUL 24,28,AUG 1-4	182	8.4 (7.0)	12.2 (8.6)	1.3 (2.1)	3.4 (5.0)	74.7 (9.7)

() = Standard Deviation

(FR = Fraser River; JS/GS = Johnstone/Georgia Strait; U.S. = Washington State;
WCVI = W.C. Vancouver Island; NC,CC,QCI = CDN. Areas N. Cape Caution)

TABLE 7. Electrophoretic results from Johnstone Strait (Area 12)
test fishing, 1986.

1986 STOCK COMPOSITION - AREA 12

Area	Week Ending Date	Samp. Size	Hanson Island (vessel 1)		
			% FR	% JS/GS	% US
12	06-Sep-86	141	50.2 (14.4)	45.4 (13.4)	4.5 (6.1)
12	13-Sep-86	153	42.9 (16.1)	52.1 (13.8)	5.0 (6.5)
12	20-Sep-86	150	37.6 (12.1)	62.2 (11.9)	0.2 (0.7)
12	27-Sep-86	150	83.7 (11.1)	16.3 (11.1)	0.0 (0.0)
12	04-Oct-86	150	30.2 (12.1)	67.8 (11.9)	2.0 (3.5)
12	11-Oct-86	150	18.5 (12.0)	78.5 (12.9)	3.1 (5.5)
12	18-Oct-86	150	36.9 (15.3)	60.2 (14.3)	2.9 (3.6)
12	25-Oct-86	150	40.9 (12.8)	58.3 (13.1)	0.8 (1.8)
12	01-Nov-86	150	24.0 (13.8)	68.9 (12.4)	7.1 (6.6)
12	08-Nov-86	150	12.5 (12.1)	67.0 (11.9)	20.5 (10.5)
Cracroft Pt.- Robson Bight (vessel 2)					
12	27-Sep-86	150	54.4 (14.1)	43.6 (13.7)	2.0 (3.9)
12	04-Oct-86	150	30.3 (15.9)	65.8 (15.8)	3.9 (4.6)
12	11-Oct-86	150	30.8 (17.4)	68.8 (17.6)	0.4 (1.6)
12	18-Oct-86	150	16.9 (13.2)	81.8 (13.3)	1.4 (3.4)
12	25-Oct-86	150	52.2 (16.3)	39.8 (16.5)	8.0 (6.7)
12	01-Nov-86	150	28.3 (15.0)	70.1 (15.9)	1.7 (4.1)
12	08-Nov-86	148	35.4 (19.4)	60.8 (18.5)	3.9 (4.3)

() = Standard Deviation

(FR = Fraser, JS, GS = Johnstone/Georgia Strait; U.S. = Washington State)

TABLE 8. Electrophoretic results from the Mid Vancouver Island Commercial fishery (Area 14), 1986.

1986 STOCK COMPOSITION - MID VANCOUVER ISLAND (AREA 14)

Area	Week Ending	Sample Size	% FR	% JS/GS	% US
14-5,7	11-Oct-86	109	9.1 (12.4)	66.5 (11.8)	24.4 (9.4)
14-5,7	18-Oct-86	150	16.9 (12.5)	74.9 (12.6)	8.3 (6.3)
14-5,7	25-Oct-86	144	37.5 (15.0)	54.0 (14.7)	8.5 (7.7)
14-9	25-Oct-86	150	9.6 (7.9)	88.7 (9.4)	1.7 (3.6)
14-5,7	01-Nov-86	142	27.1 (12.5)	71.9 (12.6)	1.0 (2.5)
14-9	01-Nov-86	140	17.9 (11.7)	74.0 (12.6)	8.1 (7.5)
14-5,7	08-Nov-86	150	18.1 (13.4)	76.5 (13.9)	5.4 (5.2)
14-9	08-Nov-86	149	20.2 (9.8)	78.3 (10.2)	1.5 (3.9)

() = Standard Deviation

(FR = Fraser River; JS/GS = Johnstone/Georgia Strait; U.S. = Washington State)

TABLE 9. Electrophoretic results from San Juan (Area 20), 1986.

1986 STOCK COMPOSITION - SAN JUAN

Area	Week Ending	Sample Size	% FR	% JS/GS	% US	% WCVI
20	27-Sep-86	151	44.5 (14.8)	54.7 (14.4)	0.7 (1.5)	0.1 (0.1)
20	04-Oct-86	150	67.2 (18.2)	20.0 (15.2)	9.5 (8.1)	3.4 (5.0)
20	11-Oct-86	150	27.7 (14.6)	49.0 (14.4)	10.1 (6.4)	13.2 (10.2)
20	18-Oct-86	150	19.0 (13.2)	13.9 (9.8)	43.7 (10.0)	23.3 (9.6)
20	25-Oct-86	100	6.4 (7.6)	49.6 (11.1)	26.0 (8.5)	18.0 (8.1)
20	01-Nov-86	200	4.7 (5.4)	15.5 (8.8)	26.7 (4.9)	53.2 (9.1)

() = Standard Deviation

(FR = Fraser River; JS/GS = Johnstone/Georgia Strait; U.S. = Washington State;
WCVI = West Coast Vancouver Island).

TABLE 10. Electrophoretic results from Nitinat (Area 21), 1986.

1986 STOCK COMPOSITION - NITINAT

Area	Week Ending	Sample Size	% FR	% GS	% US	% WCVI
21	04-Oct-86	150	11.5 (8.1)	18.8 (12.3)	0.4 (1.1)	69.4 (12.4)
21	11-Oct-86	150	29.4 (10.1)	4.2 (7.2)	0.0 (0.0)	66.3 (10.3)
21	18-Oct-86	150	3.5 (6.0)	16.9 (8.5)	2.5 (4.5)	77.1 (9.6)
21	25-Oct-86	140	5.6 (6.5)	12.2 (10.9)	11.9 (9.0)	70.3 (11.5)
21	01-Nov-86	149	0.8 (2.3)	1.2 (3.2)	5.4 (4.5)	92.6 (5.4)

() = Standard Deviation

(FR = Fraser; JS/GS = Johnstone/Georgia Strait; U.S. = Washington State;
WCVI = West Coast Vancouver Island).

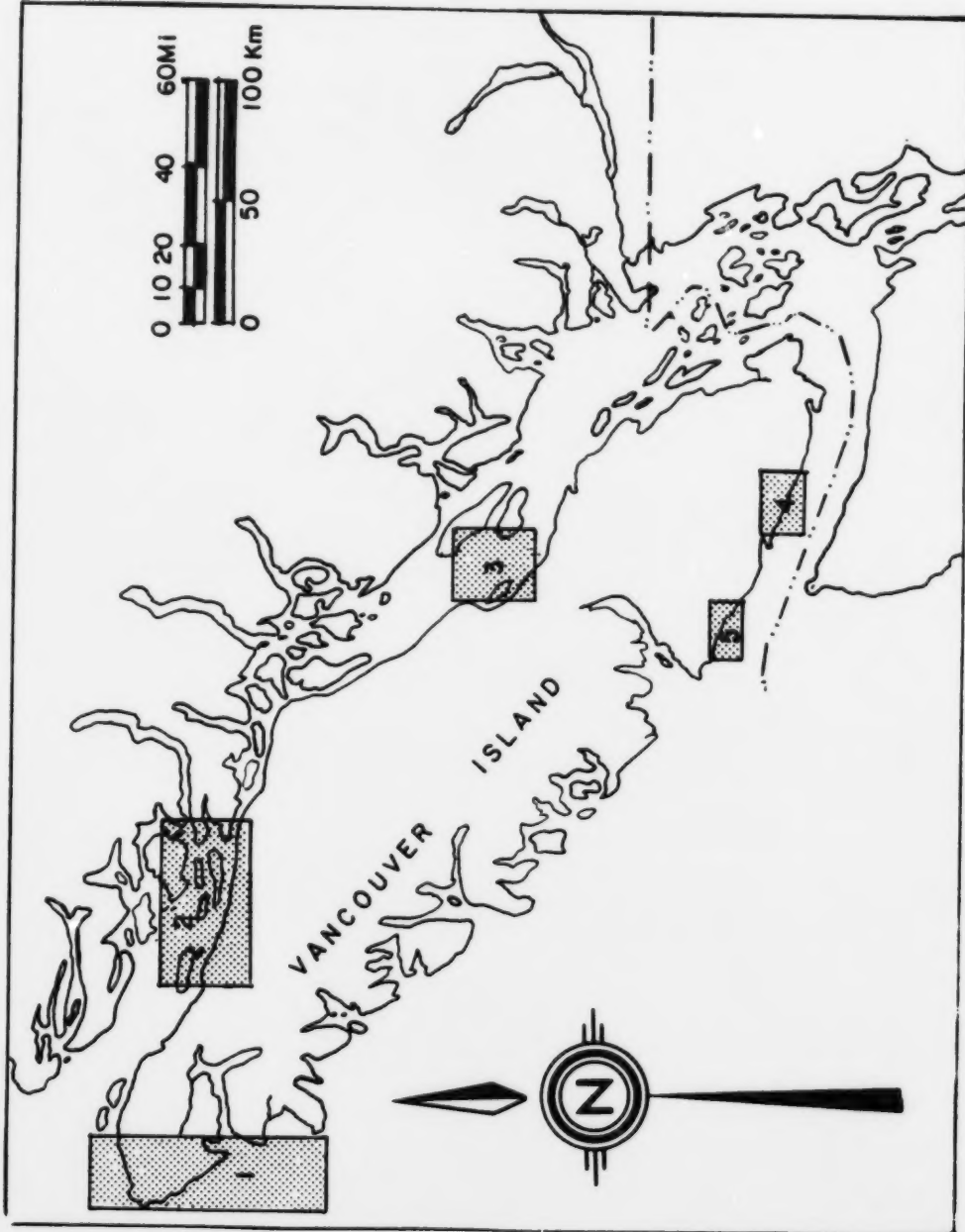


Figure 1.
Fishing Areas for 1986 (1) Northwest Vancouver Island (2) Johnstone Strait
(3) Mid Vancouver Island (4) San Juan (5) Nitinat



Figure 2. Map of upper Johnstone Strait region showing test set locations.

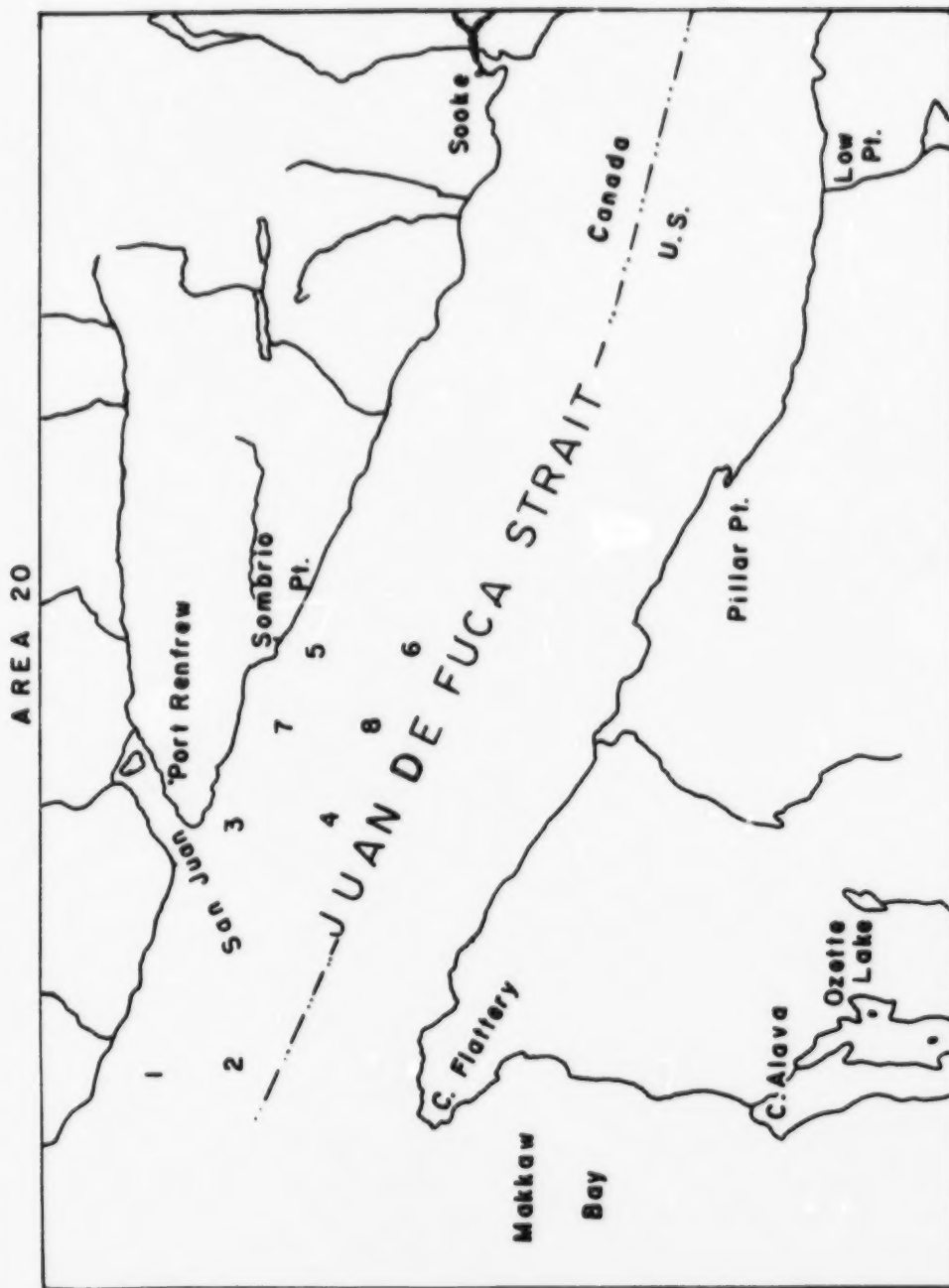


Figure 3. Chum test fishing sites for the San Juan region.

- | | |
|-------------------------|--------------------------|
| 1. Camper Bay (inside) | 5. Sombrio Pt. (inside) |
| 2. Camper Bay (outside) | 6. Sombrio Pt. (outside) |
| 3. San Juan (inside) | 7. Mid Point (inside) |
| 4. San Juan (outside) | 8. Mid Point (outside) |